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ABSTRACT

A descriptive study analyzed learners' use of comprehensive aids such as objectives and the glossary in a hypermedia tutorial. College students (n=101) read a short hypermedia tutorial on the topic of E. coli. Relationships between the use of the comprehension aids and individual characteristics such as metacognitive awareness and epistemic beliefs were evaluated. It was hypothesized that the more metacognitively skilled learners and those with more sophisticated beliefs about learning would use the aids more frequently. The findings indicate that the uses of some comprehension aids are significantly related to certain epistemic beliefs, although the relationships were not in the expected direction. The majority of the factors analyzed did not indicate a significant relationship between beliefs and the use of comprehension aids. (Author/SLD)

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The Use of Comprehension Aids in a Hypermedia Environment: Investigating the Impact of Metacognitive Awareness and Epistemic Beliefs

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Abstract

This is a descriptive study that analyzes learners' use of comprehension aids such as objectives and the glossary in a hypermedia tutorial. Students read a short hypermedia tutorial on the topic of E. coli. Relationships between the use of the comprehension aids and individual characteristics such as metacognitive awareness and epistemic beliefs were evaluated. It was hypothesized that the more metacognitively skilled learners and those with more sophisticated beliefs about learning would use the aids more frequently. The findings indicate that the uses of some comprehension aids are significantly related to certain epistemic beliefs, although the relationships were not in the expected direction. The majority of the factors analyzed did not indicate a significant relationship between beliefs and the use of comprehension aids.

Introduction

Hypermedia tutorials are widely used in classrooms throughout the country. While the textbook is still the primary source of course content, hypermedia documents are frequently supplementing and in some cases replacing the book. Web pages are an example of hypermedia-pages displayed by a computer that use multiple media and click-able links to present related information. With the increasing popularity of the Internet as an educational tool, learners are being asked more and more often to use hypermedia materials to access information and learn important concepts. These tutorials often offer a variety of comprehension aids to assist the reader. The most common aid is a glossary that can be accessed by clicking on a hyperlinked word to see the definition or a representative image. Others include a list of objectives, advanced organizers and self-test questions. Hypermedia provides the opportunity to provide these aids "when needed." In other words, they will not appear unless the learner chooses to see them. It is assumed that the inclusion of these tools can improve comprehension.

We currently know very little about the use of these aids in a hypermedia environment. A recent review by Dillon and Gabbard (1998) explored the hypermedia research literature with a focus on learning comprehension, learner control, and style (i.e., learner characteristics). They concluded that there is substantial evidence that individual characteristics such as ability, passive/active, field independence/dependence and deep/shallow processors play a role in learning from hypermedia instruction (Dillon & Gabbard, 1998). There is a strong need to understand why these characteristics may impact comprehension in a hypermedia environment. Most comprehension research on the use of hypermedia has focused on learning outcomes as opposed to the approaches.

One possible source of variability in the successful use of a hypermedia tutorial is the use of comprehension aids. Like traditional textbooks, hypermedia instructional materials often contain comprehension aids such as advanced organizers, lists of objectives, a glossary and self-check questions. The value of comprehension aids such as advanced organizers has been clearly demonstrated in reading research (Moore & Readance, 1984). Studies that incorporate advanced-organizers into computer based instruction have also demonstrated a positive effect (Kenny, 1993). One important consideration that has yet to be addressed is the use of these comprehension aids in a hypermedia environment. In a hypermedia tutorial, providing the option to access these tools does not insure use. The attributes that may impact the use of comprehension aids include metacognitive awareness and beliefs about knowledge (i.e., epistemic beliefs).

Students' metacognitive skills will significantly mediate success in most learning environments (Schraw, 1998). Metacognition literally means thinking about thinking. Metacognition has been subdivided into knowledge and regulation of cognition (Jacobs and Paris 1987). Knowledge of cognition refers to a learner's understanding of his or her own thought processes (Schraw, 1998). Knowledge of cognition includes declarative (about), procedural (how), and conditional (when) knowledge (Jacobs and Paris, 1987; Schraw, 1998). The use of a strategy is dependent on the student's awareness of the strategy (declarative), understanding of how the strategy works (procedural) and knowing when to use the strategy (conditional). Regulation of cognition is understood as those behaviors that demonstrate control of, and/or utility with, one's knowledge of cognition. Examples would include a student's ability to monitor, evaluate and set goals for their learning (Schraw, 1998). Students who lack skills such

as monitoring for understanding and goal setting tend to struggle in many learning environments (Zimmerman, 1990).

In hypermedia environments, users are faced with a constant barrage of decisions to be made. A simple example would be the "hyperlinked" term that the user will face in most hypermedia documents. The decision whether or not to follow the link should be related to the learners ability to monitor their understanding. Poor monitors will likely benefit less from the convenience of hyperlinked terms and may actually be placed at a disadvantage, as the distraction will consume valuable cognitive resources.

Epistemology refers to the study of the nature of knowledge. The epistemological beliefs held by students may have important influences on thinking and problem solving. Schommer (1990) has proposed five separate epistemological dimensions corresponding to beliefs about knowledge. Each dimension is based on a continuum from naïve to mature. The following lists the "naïve" end of the continuum for each dimension:

1. Certain Knowledge (i.e. absolute knowledge exists and will eventually be known)
2. Simple Knowledge (i.e. knowledge consists of discrete facts)
3. Omniscient Authority (i.e. authorities have access to otherwise inaccessible knowledge)
4. Quick Learning (i.e. learning occurs in a quick or not-at-all fashion)
5. Fixed Ability (i.e. ability to acquire knowledge is innate)

Research conducted with traditional instructional materials indicates that certain epistemological beliefs correlate with achievement. For example, Schommer, Crouse, and Rhodes (1992) reported that beliefs in Simple Knowledge negatively affected complex problem solving. Schoenfeld (1983) investigated some of the consequences of a belief in Quick Learning.

He reported that even experienced students who were asked to solve math problems gave up after five to ten minutes on the assumption that if they failed to solve the problem during this time, the problem could not be solved. Jacobson and Spiro (1995) found that students with naïve epistemological beliefs struggled with the non-linearity of the hypertext environments.

The present research focuses on the direct impact of metacognitive awareness and epistemic beliefs on the use of comprehension aids in a hypermedia tutorial. Metacognitive awareness, as exemplified by students who are more actively engaged in materials, should impact the use of comprehension aids. Regulation of cognition refers to higher-level activities such as monitoring for understanding and goal setting. Knowledge of cognition refers the knowledge one has about their cognition (e.g., learning strategies and memory limitations). Naive epistemic beliefs such as a belief in quick learning or simple knowledge would result in the decreased use of comprehension aids. If learning is quick and knowledge is simple, there is little reason believe additional tools such as advanced organizers would be necessary.

Two hypotheses will be tested. The first hypothesis predicts that there will be a positive correlation between the use of comprehension aids and metacognitive skills. The second hypothesis is that there will be a negative correlation between the use of comprehension aids and naive epistemic beliefs.

Method

Participants

101 students (78 females, 23 males) from a large southwestern university participated in this experiment to fulfill a class requirement.

Materials

Materials included a packet containing a 32-item Epistemological Beliefs Inventory (EBI), a 52-item Metacognitive Awareness Inventory (MAI) and a brief demographic variable worksheet. Students also completed the Nelson-Denney reading comprehension test and a syllogistic reasoning test.

Epistemological beliefs were measured using the EBI developed by Bendixen, Schraw & Dunkle, (1998). This inventory is based on Schommer's (1990) five dimensions of epistemological beliefs which include 1) certain knowledge, 2) simple knowledge, 3) omniscient authority, 4) fixed ability, and 5) quick learning. All items were written using a 5-point Likert-type scale. See Table 1 for sample items.

Students' metacognitive awareness was measured using the Metacognitive Awareness Inventory (MAI) developed by Schraw & Dennison, (1994) in which items are classified into two categories of metacognition (i.e., knowledge of cognition and regulation of cognition). All items were written using a 5-point Likert-type scale. See Table 1 for sample items.

Hypermedia Tutorial

The tutorial screen was partitioned into four areas (see Figure 1). The top 10 percent of the screen, the banner, contained links to an advanced organizer, objectives, glossary, site map (map representing the organization of the content) and self check questions. The banner was always visible. The other 90 percent of the screen was divided into three columns, the menu, content and supplementary information. The menu contained links to the four major topics in the tutorial. The content contained the text of the tutorial, which included links to relevant terms, images and other text pages. The supplementary information section displayed definitions and images when selected from the content section. For example, if while reading about E. coli, the

user was confused by the term "bacteriophage" they could click on the term and a definition would appear in the supplementary information section. While navigating through the tutorial, the students' use of the banner items and links to the glossary were recorded by a central computer.

Procedure

This study was a part of a larger study concerned with learner beliefs and hypermedia instruction. As a part of the larger study, students also completed a tutorial whose design was identical and the content was centered on the topic Yugoslavia. In order to account for any differences related to "practice effects," some of the participants completed the E. coli during their first session while others completed the Yugoslavia tutorial. In the subsequent session, the content was switched. During the initial sessions, students completed the EBI and MAI, while the reading comprehension and syllogistic reasoning tests were completed during the second session.

The participants were given thirty minutes to read the tutorial. The researcher briefly demonstrated the tutorial to each group. The demonstration included showing the students each of the comprehension aids and how to navigate through the content. The participants were told that they should study the material as they would for a class and that a test over the objectives would follow.

Results

Correlations between the use of comprehension aids and factors in the EBI and MAI can be found in Table 3. Seven factors (5 EBI and 2 MAI) were compared to the use of five comprehension aids resulting in 35 possible relationships. Of the 35 combinations, only three were statistically significant (alpha = .05, one tail). A strong positive correlation was found

between a belief in innate ability and the use of the self-check questions (r=+.271, n=101). Positive correlations were also found between a belief in quick learning and the use of the advance organizer (r=+.183, n=101) and the glossary (r=+.190, n=101). The use of two other aids and a belief in quick learning resulted in marginally significant correlations, the site map (r=+.163, n=101, p=.052) and the self-check questions (r=+.163, n=101, p=.052). Note that higher EBI scores indicate less sophisticated epistemological beliefs. This direction is the opposite of what was predicted. No significant correlations were found with the other factors in the EBI; belief in omniscient authority, simple knowledge or certain knowledge. No significant correlations were found between the use of comprehension aids and self-regulatory skills as measured by the MAI.

In summary, the first hypothesis, that there will be a positive correlation between the use of comprehension aids and metacognitive awareness was not supported. Contrary to the second hypothesis, that there will be a negative correlation between the use of comprehension aids and naive epistemic beliefs, a positive correlation was found between the use of several of the comprehension aids and quick learning. In other words, students who tended to believe that learning is quick were more likely to use the advanced organizer and glossary. A positive correlation was also found between the belief in quick learning and use of the self-check questions.

Discussion

Previous research would lead us to believe that the beliefs measured by the EBI and MAI would have a substantial impact on how learners approach these tutorials. With some minor exceptions, little evidence was found to indicate a relationship between the use of comprehension aids and learner characteristics such as metacognitive awareness and epistemic beliefs. One

possible explanation for the lack of significant effects is the indirect nature of the dependent variable, tool use. The use or disuse of a tool does not by itself indicate an inefficient approach to learning. It may be that for some, just the opposite is true. For example, for many the use of self-check questions may improve comprehension, but for the good self-regulator, the self-check questions may not be necessary. The increased use of the comprehension aids by students holding a belief in quick learning is interesting for a couple of reasons. One reason is that the comprehension aids may be viewed as "the quick" way to get the necessary information.

Another possible reason is that the task may not have encouraged the kind of deeper processing that is more commonly associated with increased metacognitive awareness and more sophisticated epistemic beliefs. Students were asked to study the tutorials as they would for a class and were given only thirty minutes with which to study. A more authentic and longer task may have been better suited to answer the questions posed. A study of longer duration would also afford the opportunity to move beyond the dichotomous variable of tool use (yes or no). A study of longer duration could begin to look at the frequency of tool use and when it was accessed.

To address the need for a better understanding of the use of comprehension aids in light of learner beliefs, further research should gather 'online' data about the rationale that is used by the learner when deciding whether or not to use a comprehension tool. For example, while some students may use a tool frequently, depending upon their current understanding, the use may or may not be an effective use of their time. Presumably, learners referencing the objectives prior to reading are making better use of their time than the student who stops to read the objectives for the first time in the middle of the text.

This descriptive study represents and important beginning in the analysis of how different learners approach hypermedia instruction. Studies such as this combined with qualitative investigations of learning with hypermedia (e.g., Hill & Hannifin, 1997) are crucial to making informed recommendations about the use of hypermedia in schools. While many are quick to adopt new technologies in the service of learning, we need to constantly evaluate how these new tools impact a variety of learners.

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Table 1

Factors and Sample Items from the EBI and MAI

Instrument	Factor	Item
EBI	Certain knowledge	"What is true today will be true tomorrow."
EBI	Simple knowledge	"Too many theories just complicate things."
EBI	Omniscient authority	"People should always obey the law."
EBI	Fixed ability	"How well you do in school depends on how smart you are."
EBI	Quick learning	"Working on a problem with no quick solution is a waste of time."
MAI	Regulation of cognition	"I organize my time to best accomplish my goals."
MAI	Knowledge of cognition	"I understand my intellectual strengths and weaknesses."

Table 2

Means and Standard Deviations for factors in the EBI and MAI

Variable	M	SD	Minimum	Maximum
Simple knowledge	3.10	.51	1.50	4.50
Certain knowledge	2.32	.51	1.10	3.70
Omniscient authority	3.16	.70	1.00	5.00
Quick learning	1.92	.55	1.00	3.80
Fixed ability	2.69	.65	1.43	4.71
Regulation of cognition	3.42	.42	2.56	4.66
Knowledge of cognition	3.67	.39	2.61	4.78

Table 3

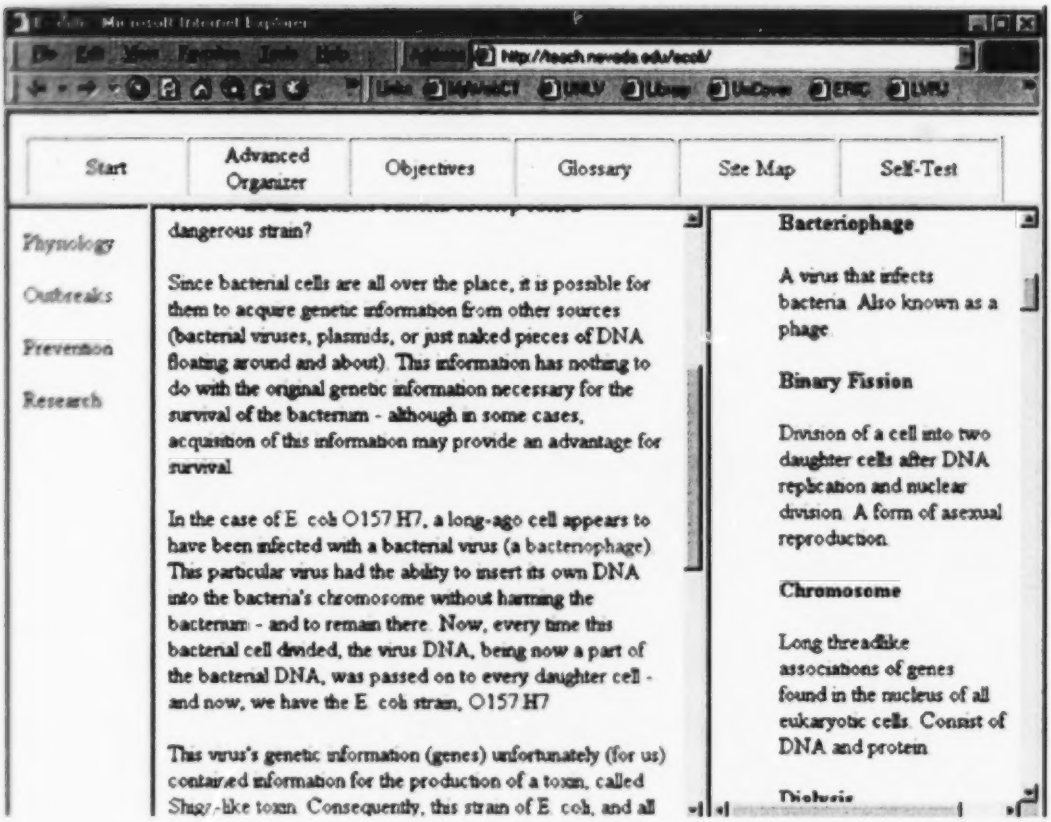
Correlations Between Learner Beliefs (EBI and MAI) and the Use of Comprehension Aids

	Advanced 0rganizer	Objectives	Glossary	Site map	Self-check
Omniscient authority	0.091	0.002	0.077	-0.032	-0.082
Innate ability	-0.016	0.125	0.032	-0.007	.271**
Simple knowledge	0.04	0.052	0.141	0.066	0.043
Quick learning	.183*	0.09	.190*	0.163	0.163
Certain knowledge	0.062	-0.021	-0.008	-0.015	0.054
Regulation of cognition	-0.008	0.009	-0.086	-0.044	0.06
Knowledge of cognition	-0.144	-0.028	0.011	-0.113	-0.086

n=101
*p<.05, one tail
**p<.01, one tail

Figure 1

E. coli Hypermedia Tutorial


Start
Advanced Organizer
Objectives
Glossary
Site Map
Self-Test
Physiology
Outbreaks
Prevention
Research
dangerous strain?
Since bacterial cells are all over the place, it is possible for them to acquire genetic information from other sources (bacterial viruses, plasmids, or just naked pieces of DNA floating around and about). This information has nothing to do with the original genetic information necessary for the survival of the bacterium - although in some cases, acquisition of this information may provide an advantage for survival.
In the case of E. coli O157:H7, a long-ago cell appears to have been infected with a bacterial virus (a bacteriophage). This particular virus had the ability to insert its own DNA into the bacteria's chromosome without harming the bacterium - and to remain there. Now, every time this bacterial cell divided, the virus DNA, being now a part of the bacterial DNA, was passed on to every daughter cell - and now, we have the E. coli strain, O157:H7.
This virus's genetic information (genes) unfortunately (for us) contained information for the production of a toxin, called Shiga-like toxin. Consequently, this strain of E. coli, and all
Bacteriophage
A virus that infects bacteria. Also known as a phage.
Binary Fission
Division of a cell into two daughter cells after DNA replication and nuclear division. A form of asexual reproduction.
Chromosome
Long threadlike associations of genes found in the nucleus of all eukaryotic cells. Consist of DNA and protein.

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